Catalytic Cracking of Light Oil

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THE development of fluid catalytic cracking processes for the production of high octane gasoline is considered as one of the outstanding technological achievements of the oil industry in recent years. Through the advantages of the new technique, the oil industry has been able to meet the vital demands of the war effort for an unlimited supply of high-octane gasoline. The product so produced is of such strength that it must be cut with gasoline of lower octane rating in order to be used as fuel in combustion engines of present-day design. It is truly a super fuel.

The use of catalysts in chemical reactions has been regarded as common practice by chemical operators for many years, yet knowledge of exact catalytic mechanism is not great. A catalyst is a substance which takes part in a chemical reaction without itself being altered or consumed. When properly chosen its presence will cause a reaction which normally proceeds at a low rate to accelerate tremendously. Catalysts, therefore, do not sponsor impossible reactions but instead select a low speed reaction and hasten the attainment of its equilibrium. By correct application of these catalytic principles, the oil industry is able to convert low grade furnace oil into super-octane gasoline, and conversion takes place readily at low temperature and atmospheric pressures. Such a conversion is known as a cracking process.

Solid materials are usually used as catalysts in cracking processes. Since experimental data have indicated that reaction stimulation takes place on the surface of a catalyst, industrial research has commissioned many projects concerned with the study of cracking reactions in relation to catalytic surface variables. The preparation of satisfactory surfaces demands very ingenious manufacturing procedures. Impurities also affect the performance of catalytic materials; those which increase effectiveness are called "promoters," and the other types are known as poisons.

Before the advent of catalytic cracking processes there was used in industry another process which yielded approximately the same type of reaction to a considerably lesser degree known as the thermal process. When oils were subjected to the high temperatures and pressures, the long-chain molecules which primarily compose the furnace-type oil were cracked to form a mixture of different short-chain molecules. A relatively small percentage of these short chains were reformed into the high-octane structure which is considerably more branched in nature. After separation by distillation, the fractions which had not attained the required octane rating were recycled through the cracking unit with subsequent expenditure of additional heat energy. The product contained sulfur and gum impurities which necessitated further refining for their removal. Carbon formation and deposition on hot surfaces caused by high temperature decomposition of the slow moving liquid caused difficulty.

Important commercial applications of catalytic cracking are the Houdry, Thermafor, and Fluid processes. In the Houdry process the catalyst remains in place during cracking and regeneration. Two units are usually provided in order that the process be continuous. While one operates, the other is regenerated by burning the carbon deposit with a gas mixture. The Thermafor process uses granules of catalyst which move countercurrent to the vapor steam. The granules cascade downward over baffles in the reactor, and over spiral fins in the regenerator.

The fluid process is unique in that it suspends finely divided particles of catalyst in the streams of oil vapor and regenerating air-gas mixture. Such a process has the important operating advantage of eliminating mechanical means for moving the catalyst or changing the vapor stream direction through the cracking or regenerating units. Pumps to deliver the liquid feed to the vaporizers, and blowers to feed the regenerators are the only mechanical equipment needed. The pneumatic lift principle is used to circulate the catalyst.

Raw materials for the fluid catalytic cracking plant is usually a light oil with an API gravity of about 30 degrees. The finely divided catalyst is delivered to the plant by railroad, unloaded, and carried to the storage bin by pneumatic conveyors. Again by pneumatic means it is conveyed to the oil vapor pipe and intimately mixed with that vapor. The catalyst is carried to the cracking chamber in which the vapors are directed in such a manner as to be evenly distributed throughout. The reaction chamber is a steel vessel which maintains temperatures in the range of 800 degrees Fahrenheit, and pressures of 10 to 20 pounds per sq. inch.

Important to the economics of the process is

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likely to be used during the post-war period of automotive fuel development.

The yield of aviation gasoline from the fluid process is extremely high. Each barrel of light oil feed which is converted by this process ultimately yields two-thirds barrel of 100 octane aviation fuel satisfactory to all specifications. If, during the refining operations which follow the cracking process, a hydrogenation process is included, a yield of approximately 80% of 100 octane aviation gasoline is possible.

Fluid catalytic methods will be the major cracking process when present-day construction programs are complete. In the future, when normal conditions are restored, fluid catalytic cracking will be an efficient method of converting heavy petroleum fractions into excellent motor fuels.

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the recovery of the catalyst after the cracking operation. Recovery of approximately 85% of the catalyst is accomplished by passing the entire mixture of cracked vapor and suspended solid through a series of cyclone separators. The accumulated catalyst is then carried to the regeneration units where the coating of carbon is burned off the particle surface by by-product gases in the presence of air. The temperature of the regenerator is held near 1,000 degrees Fahrenheit. The mixture of combustion gases and solid particles leave the regenerator immediately and are carried then through another series of cyclone separators and also a Cottrell precipitator. The catalyst particles are ready again for mixture with uncracked oil-vapor.

All fluid catalyst cracking plants in operation today are producing fuels for the war effort. The catalysts used in the production of these high-octane fuels are synthetic, and not at all similar to the types which are used in normal times. As mentioned previously, catalysts are selective in their action. Today's catalysts are particularly applicable for war-fuel production, but others are